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FARMERS' BULLETIN No. 288.

THE NONSACCHARINE SORGHUMS.

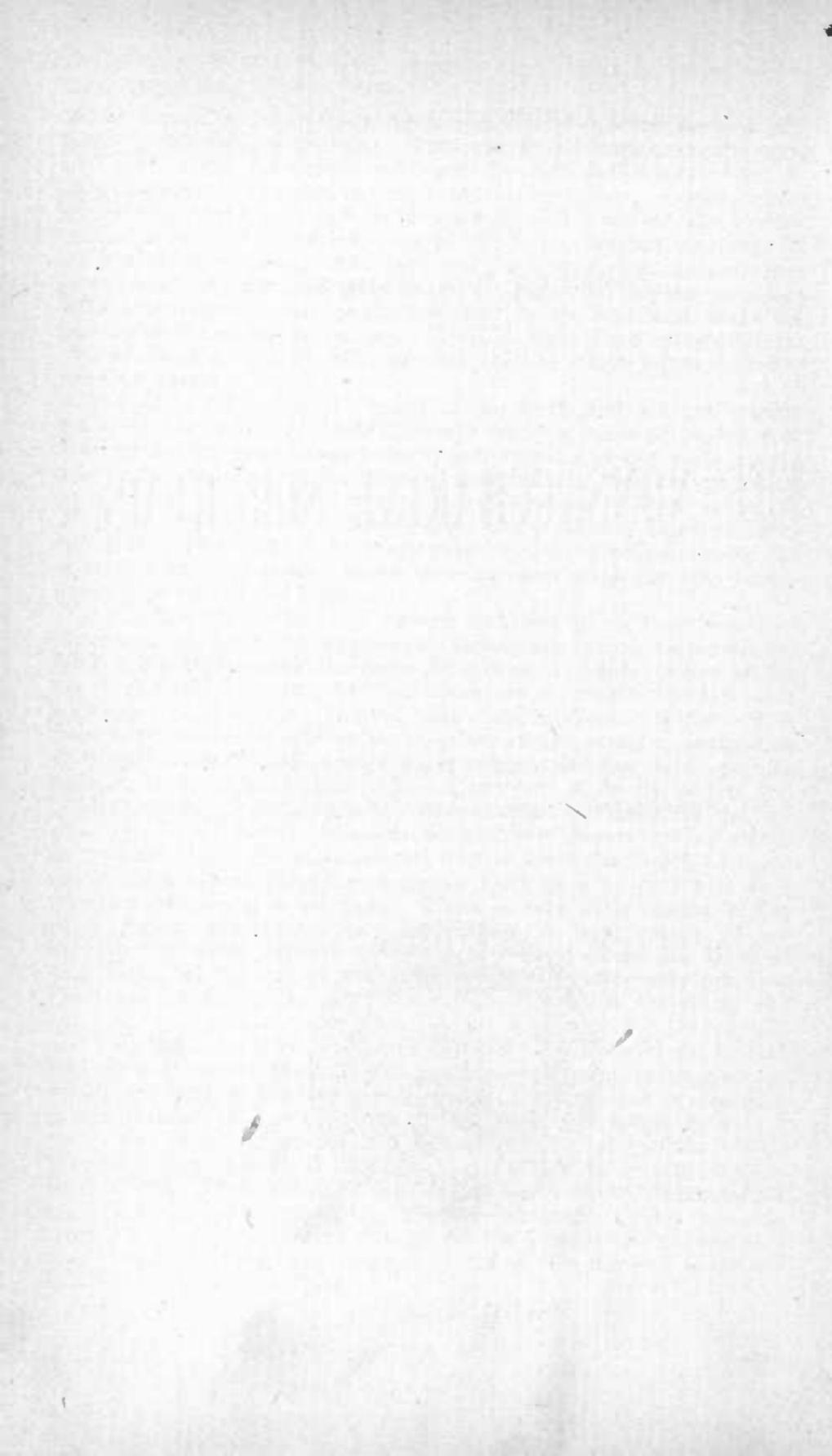
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., February 25, 1907.

SIR: I have the honor to transmit herewith a paper entitled "The Nonsaccharine Sorghums," by Mr. C. W. Warburton, Assistant Agriculturist, prepared under the direction of the Agriculturist in Charge of Farm Management Investigations. I recommend that this be published as a new bulletin to supersede Farmers' Bulletin No. 37.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE NONSACCHARINE SORGHUMS.

CLASSIFICATION OF SORGHUMS.

All the varieties of sorghum now in cultivation are supposed to have originated from a single species native to tropical Africa. The differences which mark them so far as botanical characters are concerned are comparatively slight and unimportant. The forms cultivated in the United States may be divided into three classes: (1) Broom corns, (2) saccharine sorghums, and (3) nonsaccharine sorghums.

The broom corns are distinguished by their dry, pithy stalks and by their long, loose, open seed heads, which are used in the making of brooms and brushes. The saccharine varieties are marked by their tall, leafy stems, which are full of sweet juice. The seed heads of the different varieties are quite variable in shape and color. The nonsaccharine varieties are usually more stocky than the saccharine sorts and contain less sap, though some of them are quite juicy and sweet. The saccharine sorghums are grown for forage and the production of sirup; the nonsaccharine sorts for forage and grain. This bulletin deals only with the latter class.^a

INTRODUCTION INTO THE UNITED STATES.

Although chicken corn and some of the other less important nonsaccharine sorghums were brought into this country in colonial times, none of the varieties became prominent as farm crops until about twenty years ago. The settlement of the semiarid section of the Great Plains in Kansas, followed by the development of similar portions of Oklahoma and Texas, caused a demand for a drought-resistant grain crop to take the place of corn, and demonstrated the usefulness of Kafir corn and milo. These sorghums had been introduced some years previous, but were considered of little value up to this time. Some of the varieties of the dura group had been brought into the Southern States at a much earlier date, but they had only been grown in a very limited way. Kafir corn quickly found favor in Kansas, and the area devoted to it increased steadily up to 1900. Since

^a Farmers' Bulletins No. 174, "Broom Corn," and No. 246, "Saccharine Sorghums for Forage," discuss the first and second classes of the sorghums.

that time its acreage has remained quite constant, and the crop is one of the most important ones in the State. It is grown largely in Oklahoma also, while in Texas Kafir corn and milo are the most popular crops in the Panhandle and adjacent sections.

THE GROUPS OF NONSACCHARINE SORGHUMS.

The nonsaccharine varieties of sorghum principally grown in the United States are divided into two groups: (1) The Kafir corn group and (2) the dura group. The Kafir corn group takes its name from the tribe of Africans from whom it was obtained when introduced

into this country. It includes Red Kafir corn, White-Hulled White Kafir corn, and Black-Hulled White Kafir corn, and is characterized by its long, erect, slender heads, compact and full of obovate seeds (egg-shaped with the large end outermost), either white or red in color. White-Hulled White Kafir corn is of no importance at the present time, having been replaced by Red Kafir corn and Black-Hulled White Kafir corn.

White milo,

FIG. 1.—Head of White Kafir corn.

African millet, and Indian millet are old names for the white varieties of Kafir corn. Black-Hulled White Kafir corn is now commonly known as White Kafir corn and as Black-Hulled Kafir corn, and the term "White Kafir corn" as used in this bulletin refers to this variety. A head of White Kafir corn is shown in figure 1.

The dura group of sorghums includes brown dura, Jerusalem corn, and yellow milo. These varieties are characterized by their thick, compact, ovate (egg-shaped) heads, which frequently turn down, or "gooseneck," and their large flattened seeds, white in Jerusalem corn, reddish brown in brown dura, and reddish yellow in yellow milo.



In California this group is generally known as Egyptian corn. Various names have been applied to the different varieties by seedsmen and farmers in other sections. Among those by which brown dura is known may be mentioned dhoura (also spelled durra, durah, doura, and in various other ways), Dhoura corn, Rural Branching dhoura, and Rural Branching sorghum. Yellow milo is known as Millo maize or Milo maize, Yellow Branching sorghum, Dwarf milo, and Red milo maize. Jerusalem corn has also been known as Egyptian Ricc corn. A head of yellow milo is shown in figure 2.

CHARACTERISTICS OF THE DIFFERENT VARIETIES.

The several varieties of Kafir corn are short, stocky, broad-leaved sorghums, producing a considerable quantity of excellent forage in addition to a good grain yield. They are decidedly drought resistant, in that they are able practically to suspend growth during very dry periods. Later, if rain falls, these varieties will resume growth and will produce a crop of seed. Occasionally, however, the rains are so long delayed that they fail to mature seed before frost. The dura group, especially yellow milo, continues growth during a drought and produces some seed under almost any conditions. For this reason yellow milo is better adapted than Kafir corn to sections of very low rainfall. With good cultivation large crops of both Kafir corn and milo may be produced with 10 to 12 inches of rain during the growing season. A field of yellow milo grown under favorable conditions is shown in figure 3.

The different varieties of Kafir corn, especially when selected seed is used, are very uniform in growth, and as the heads are always erect the crop is easy to harvest by any of the common methods. The dura group is much more variable in height, and as the heads are frequently recurved, or goosenecked, the crop is more difficult to

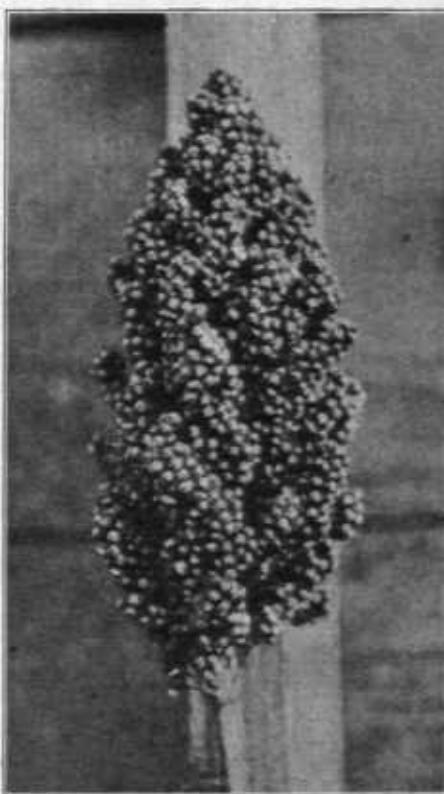


FIG. 2.—Head of yellow milo.

harvest than Kafir corn. This may be largely obviated, however, by thick planting.

The stalks and leaves of Kafir corn remain green until the head is fully matured, while in the varieties of the dura group they are nearly dead when the seed ripens. For this reason Kafir corn is usually considered a better forage plant than any of the other sorts. The stalks of Kafir corn frequently contain considerable sweet sap, and milo is occasionally quite juicy, but Jerusalem corn and brown dura are generally dry and pithy. As the sweet juice adds materially to the palatability of the fodder this is an additional reason



FIG. 3.—Field of yellow milo.

for using Kafir corn as a forage crop in preference to any of the varieties of the dura group.

Kafir corn requires from 110 to 135 days to mature seed; milo, Jerusalem corn, and dura will ripen in 90 to 110 days. An objection frequently urged against Jerusalem corn and dura is that the seed shatters badly as soon as it matures; milo and Kafir corn give little trouble in this respect. All of the varieties are much relished by birds, and considerable seed is destroyed by them. It is not advisable to plant small patches of any of these sorghums where sparrows are numerous, but the damage where large fields are grown is comparatively slight.

IMPORTANCE OF THE CROP.

SECTIONS WHERE SORGHUMS ARE VALUABLE.

The nonsaccharine sorghums are important as grain and forage crops in regions of slight or moderate rainfall and high summer temperatures. As they are of tropical origin they can not be grown in the extreme north or at high altitudes. Although some progress has been made in securing early strains, at the present time they can hardly be depended on to mature seed very far north of the southern boundary of Nebraska. Some of the varieties are of value as forage crops, however, for a considerable distance farther north. In all the middle and southern portion of the Great Plains, in the semi-arid Southwest, and in the central valleys of California these sorghums make the most acceptable substitutes for corn which can be grown. They are especially valuable for growing on "new land." Kafir corn is most useful in Kansas, especially the western two-thirds of the State, and in Oklahoma and Texas. Yellow milo, owing to its earlier maturity and greater drought resistance, is of value at higher altitudes and in drier sections than Kafir corn. The region best adapted to milo includes the Panhandle section of Texas, the western portion of that State, western Oklahoma, western Kansas, eastern Colorado, and portions of New Mexico. Milo is a promising crop in southern Nebraska and wherever a dry land crop is desired in the Southwest.

In the central valleys of California there is some demand for a crop which can be planted after wheat and barley are harvested and which will furnish fodder and grain with little or no irrigation. The nonsaccharine sorghums best fill these requirements. Jerusalem corn and brown dura are the sorts most largely grown. These varieties are of little value as forage, however, and it is probable that an early-maturing strain of Kafir corn could be introduced to advantage.

ACREAGE GROWN.

As the acreage of nonsaccharine sorghums is not reported by the Bureau of Statistics, and as the reports of the Bureau of the Census do not fully differentiate between the saccharine and nonsaccharine varieties, it is impossible to give the exact acreage of these crops in the United States. However, the production in Kansas and Oklahoma is reported by the boards of agriculture of those States, and from their figures a fairly accurate estimate of the acreage of the entire country may be made. It is probable that from 1,400,000 to 1,600,000 acres are devoted to nonsaccharine sorghums annually and that the crop produced is worth from 12 million to 15 million dollars.

In Kansas at the present time from 500,000 to 550,000 acres of

Kafir corn are grown, the crop being excelled in importance only by corn and wheat. The acreage is considerably increased in dry years, when the acreage of corn is reduced, or when winter wheat fails in the western and central portions of the State. In addition, about 20,000 acres of milo and 2,000 acres of Jerusalem corn are grown annually. The maximum production of nonsaccharine sorghums in Kansas to date was reached in 1902, when nearly 800,000 acres were devoted to these crops. In Oklahoma the annual acreage of Kafir corn is from 300,000 to 350,000, with an additional 150,000 acres in milo. No accurate figures on the production of these crops in Texas are available, but it is probable that the acreage in Oklahoma is at least equaled. The nonsaccharine sorghums are not important in the other States except in California, which annually produces about 50,000 acres of "Egyptian corn."

SOILS ADAPTED TO THE CROP.

The sorghums grow well on almost any good tillable land. Any soil which would be considered good for corn should produce profitable crops of the varieties here discussed. In general, a soil containing some sand is considered more drought resistant than are the finer clays; consequently, a sandy loam or a clay loam containing a small percentage of sand will usually be found most satisfactory. The "red land" section of Oklahoma and northern Texas is specially adapted to these crops. A very light sand is not desirable, nor is a very heavy clay. While the roots of Kafir corn and milo do not penetrate to any great depth, they fill the upper three feet of soil quite completely. They are thus enabled to secure a large part of the available plant food in the soil and make fair crops on rather poor land; the additional returns secured on good land are sufficient however, to justify its use for growing the sorghums. Manure can be used with profit on fields which have been in cultivation for some time or on light sandy soils. On newly broken sod these sorghums usually make fair yields with very little cultivation and are among the best crops for planting on "new land" in the Southwest.

DROUGHT RESISTANCE.

All the varieties of nonsaccharine sorghums are decidedly drought resistant, although there is considerable variation in their power to withstand long periods of dry weather. The sorghums, by reason of their numerous small roots, have the power to take up a greater percentage of the soil moisture than most other plants. They also apparently make better use of this moisture than do many of the other cultivated crops. Some of the varieties of nonsaccharine sorghum, especially milo and Kafir corn, are better able to withstand

drought than are the saccharine sorts. These plants are also remarkably resistant to injury from hot, drying winds, and if favorable conditions follow a period of drought they resume growth quickly.

ALKALI RESISTANCE.

In sections where injurious salts are present in the soil, it is generally recognized that the various sorghums are strongly alkali resistant. In Egypt the sorghums are among the first crops planted on alkali land when an attempt is made to reclaim it. In alkali regions in the Southwest they will grow and make fair yields where most other crops fail. Sorghum will withstand greater amounts of alkali than any other important field crop with the exception of well-established alfalfa. Young alfalfa, however, is much more readily killed by alkali than is sorghum.

EFFECT OF SORGHUMS ON THE LAND.

The sorghums are generally considered exhausting in their demands on the soil and injurious in their effect on succeeding crops. They are vigorous-growing, comparatively shallow-rooting plants, which draw quite heavily on the fertility of the surface soil; but in reality they take little more plant food than a corn crop of equal tonnage. The principal injury to the following crop, where any occurs, is usually due to the bad physical condition in which the soil is left by the sorghum. This crop makes its growth late in the season and at that time draws heavily upon the soil moisture. The soil when plowed turns up rough and cloddy and is not in good condition to absorb moisture or to retain it. As the water supply in the sections where sorghum is important is frequently not more than sufficient under the best conditions for crop growth, the succeeding crop suffers materially from lack of moisture. If the soil is properly plowed and placed in good mechanical condition, little injury usually results.

Where the stalks are large and the stubble is likely to prove troublesome, the stubs may be turned out as soon as the crop is cut by running a small plow under them or by disking. If the stubble is plowed out, the clods should be broken with a harrow or clod crusher and the field then plowed deep enough to turn the stubs under. Figure 4 shows a field after the first plowing. Whenever possible, sorghum stubble should be plowed in the autumn, as the action of the frost tends to break up the clods. If the field is to be sown to fall grain, it can usually be put in better condition by thorough disk ing than by plowing and harrowing. The sowing of small grain after any of the sorghums is a practice which can not be generally recommended, especially where the rainfall is not abundant.

PREPARATION OF THE SOIL.

Land for planting to sorghum should be broken from 5 to 8 inches deep, if possible some weeks before planting.^a Fall plowing is of advantage where practicable, as the soil is then in best condition to absorb any rain which may fall either before or after planting. However, good crops of Kasir corn and milo are grown by dropping the seed in every third furrow while breaking new land, the sod being turned only 2 or 3 inches. When planted in this way no cultivation is given. Under most conditions the increased yield of fodder and grain will repay any extra effort made in the preparation of the land and the cultivation of the crop. Before planting time the



FIG. 4.—Field showing sorghum stubs plowed out.

field should be harrowed so as to make the land smooth and mellow, secure a good seed bed, and kill any weeds which may have started. As the sorghum plants grow very slowly for some weeks after germination it is important to have the field as clean as possible at planting time.

In California and in other sections where irrigation is practiced, it is customary to irrigate the land before plowing, then plow and harrow, and plant the seed as soon thereafter as possible. Occa-

^a Farmers' Bulletin No. 266, entitled "Management of Soils to Conserve Moisture, with Special Reference to Semiarid Conditions," contains a very complete discussion of the preparation of the soil and the cultivation of crops in the sections where the nonsaccharine sorghums are important.

sionally a second irrigation is given later in the season, but more frequently the crop is grown with but a single watering and without cultivation.

PLANTING.

DATE OF PLANTING.

As the sorghums grow best in warm weather, the seed should not be planted until all danger from frost is past and the soil is thoroughly warm. In general, about fifteen or twenty days after the time for corn planting may be considered safe. In the South early seeding is usually desirable, as the first crop matures soon enough to secure a second crop of fodder and sometimes a second crop of grain. Where Kafir corn and milo are grown on a large scale it is customary to continue the planting over a considerable period in order to extend the harvesting season. Milo can be planted at least ten days later than Kafir corn on account of its earlier maturity. In California, Egyptian corn is usually grown on land where barley or wheat has been harvested, so that planting is generally delayed until June.

QUANTITY OF SEED NECESSARY.

The quantity of Kafir corn seed to plant to the acre varies according to the method of planting, the use to be made of the crop, and the conditions under which it is grown. When grown in rows for the maximum yield of both fodder and grain, 6 or 8 pounds to the acre in 3½-foot rows are desirable, although this quantity is frequently reduced to 3 or 4 pounds. Thin planting, however, produces coarse stalks which are not readily eaten by stock and a small number of large heads which yield less grain than the many small ones resulting from thicker seeding. When the stalks are a considerable distance apart, the heads frequently do not grow entirely out of the "boot", or sheath, and the enclosed part of the head rots or fails to mature seed. Where the crop is to be harvested by hand, thin planting is desirable. For hay and pasture it should be much thicker—one-half to 1 bushel of seed to the acre in rows or drills and 1 to 2 bushels in broadcast seeding. On account of the larger seed of the dura group, heavier planting is necessary—9 to 12 pounds per acre in rows or 1 to 1½ bushels in drills. As thin planting tends to produce goose-necked heads in this class of sorghums, it is never desirable. The largest yields of grain from all varieties may be secured from 3 to 3½ foot rows, with the stalks 2½ to 4 inches apart in the row. In very dry localities, or where the crop receives little cultivation, the stalks should be thinner than where conditions are more favorable.

METHODS OF PLANTING.

Listing.—In the sections of Kansas, Oklahoma, and Texas where the nonsaccharine sorghums are largely grown, the common method of planting all the cultivated crops is with the lister. With this implement the seed is planted in the bottom of a furrow, and is thus placed several inches below the general level of the field. This furrow is filled by the first two cultivations. Listed crops are said to be better able to resist drought than are the surface-planted ones because their main root system is farther below the surface of the soil. Corn and the sorghums, however, throw out many feeding roots from the portion of the stalk covered by cultivation, so that there is really little difference in the depth of the main roots of listed and shallow-planted crops.

The principal advantage from listing comes in the protection afforded the young plants from the strong winds often prevailing in the spring, and from the sand carried by these winds, which sometimes cuts the plants off close to the ground. Listing the crop delays its maturity several days, as the young plants in the bottom of the furrow are checked by lack of heat and light, and it is therefore not to be recommended in sections where the growing season is short or when the seed is planted late. In wet seasons listing is a disadvantage, as the furrow fills with water and the young crop is washed out or covered with sand and mud. If the plants are not yet up, the bottom of the furrow sometimes bakes so hard that they are not able to break through the crust. In listing it is customary to use a planter with special sorghum plates. The most common implement is the combined lister and planter.

Surface planting.—Recent tests have shown that in many sections where the lister is largely used fully as good yields may be secured from surface planting. In surface planting, the ordinary two-row corn planter may be used when provided with sorghum plates, or enough of the holes in a grain drill may be stopped to give the desired distance between the rows. The grain drill distributes the seed rather more evenly along the row than the planter. If the corn planter is used and the drills are desired closer than $3\frac{1}{2}$ feet, the rows may be straddled.

Drilling and broadcasting.—When the crop is desired for hay or pasture, good results can be secured by sowing the seed with a grain drill with all the holes open, or by broadcasting. If the seed is sown broadcast it may be covered by harrowing or disking.

CULTIVATION.

When the crop has been listed, the first cultivation is usually given by running a harrow lengthwise of the rows. The young sorghum plants grow very slowly at first, so that frequent and shallow cultiva-

tion is necessary to keep the weeds in check. Harrowing in the direction of the rows throws only a small quantity of earth into the lister furrows, and does not cover the young plants. The harrow may be used until the plants reach the top of the lister furrow, or what is known as the "sled," or lister cultivator, may be substituted. One type of this cultivator is shown in figure 5. In other styles of this machine the knives are replaced by disks. After the plants get above the general level of the field any ordinary type of cultivator can be used to advantage. While the plants are small and before the roots spread into the space between the rows, one cultivation $3\frac{1}{2}$ to 4 inches deep should be given. Later cultivation should be frequent and shallow, to maintain an earth mulch and check evaporation.

When the crop is surface planted the harrow is the best tool for early cultivation, running the same way as the rows. Later tillage should be the same as for the listed crop, using any of the ordinary types of walking or riding cultivators. Frequent cultivation is essential when the plants are

small, especially on fields that have been cropped for some years. On sod land good crops are usually grown with only one or two cultivations, or with none at all. In California, where irrigation is practiced, the common method is to grow the crop without cultivation, but one or two workings greatly increase the yield.

Where the crop is drilled, harrowing when the plants are from 3 inches to a foot high is frequently of benefit.

HARVESTING.

When the crop is cut for fodder the grain should be fairly mature; if the heads only are removed they should be fully ripe. For hay the crop may be cut at any period of growth from the time the plant comes into bloom until the seed is in the hard dough stage. For silage it should be harvested when the grain is in the dough stage. If used as a soiling crop, the stalks may be cut at any time after they are

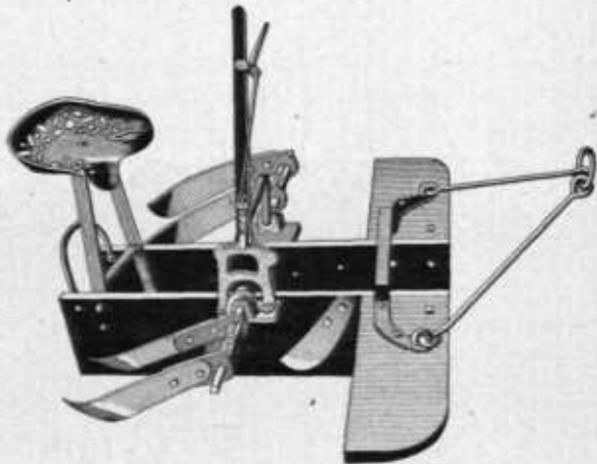


FIG. 5.—A lister cultivator.

large enough to handle conveniently, but can be fed with most profit from the time the plant comes into bloom until it approaches maturity.

When grown in rows the crop is ordinarily harvested with a corn binder and put in large shocks to cure. It can later be thrashed for grain or fed as fodder. A common type of corn harvester is shown in figure 6, while figure 7 shows a field of Kafir corn in shock. The stalks may also be cut with the "sled-cutter" commonly used in the corn belt before the row harvester was introduced, or by hand with a corn knife. Where a large area is to be harvested the saving effected by the use of the most improved machinery fully justifies any additional expense in its purchase.

Ordinarily, when the crop is to be fed without thrashing, the fodder



FIG. 6.—Cutting Kafir corn with a row binder.

is allowed to stand in the shock until wanted. As the loss from handling in this way is slight, owing to the dry climate, the method is quite practical; but it is advisable to stack a portion of the crop near the feed lot for feeding in stormy weather or when the shocks are covered with snow. A handy rack for hauling the fodder from the field is shown in figure 8. When the fodder is to be hauled a considerable distance before feeding and it is not too tall and coarse it is sometimes baled for convenience in handling. The bundles are not opened in baling, but are simply compressed and bound together. For this purpose a hop baler is the most practical machine, as the ordinary hay presses are too small for compressing the bundles.

Where the fodder is not desired the heads may be removed by hand, using an ordinary pocket or butcher knife, or by a special header

attached to the wagon box and driven by a sprocket on the rear wheel of the wagon. A header of this sort is shown in figure 9. When the crop is harvested in this way the heads should not be thrown in piles unless they are thoroughly dry, as they heat quickly if at all damp or green. If the heads are not dry when harvested they should be spread in thin layers to cure.

If the crop is drilled or sown broadcast it may be cut with an ordinary grain harvester. For this purpose it is customary to use an open-end elevator. When the crop is sown in this way the heads can be removed with a grain header. The stalks may then be cut and stacked for stover or they may be pastured. When cut for hay



FIG. 7.—Field of White Kafir corn in shock.

a mower is generally used; the hay is allowed to cure partially in the swath, then raked into windrows, where the curing is completed, and stacked with a sweep rake and swinging stacker. Under favorable conditions the hay will cure in three or four days.

THRASHING.

If the grain is to be fed alone, the fodder may be run through an ordinary thrasher with the concaves removed and boards substituted, or the heads only may be inserted, the grain thrashed out, and the stalks then removed. Both these operations involve much heavy labor, however. A better way is to remove the heads from the stalks and run only the heads through the machine. If the crop is cut for fod-

der the heads may be removed by hand, using an ordinary knife, or by laying the bundle on a bloek and cutting them off with a broadax or corn knife. The seed should be thoroughly dry when thrashed; if it is not, it should be spread in thin layers to dry, as it heats quickly if stored in bins when damp. The grain also absorbs moisture readily, so that in damp weather it is necessary to shovel it over occasionally.

YIELDS.

The yield of thrashed grain usually secured varies from 25 to 50 bushels to the acre, although considerably larger crops have been reported. On upland at the Kansas Agricultural Experiment Station, Kafir corn averaged 46 bushels per acre and eorn $34\frac{1}{2}$ bushels in a test covering eleven years. Results secured at the Oklahoma Agricultural Experiment Station are equally favorable to Kafir corn, both in yield of grain and fodder. Farther west, in the region better adapted to the sorghums and less favorable to eorn, the comparison

is more decidedly advantageous to Kafir corn. White Kafir corn yields rather more than the red variety, and yellow milo is the

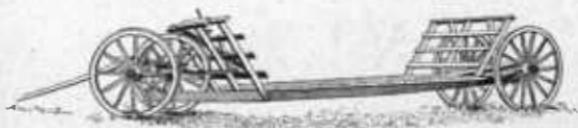


FIG. 8.—A convenient rack for hauling fodder.

heaviest yielder of the dura type. The usual return secured in California from Jerusalem eorn and dura (Egyptian corn) with one irrigation and no cultivation is about 25 or 30 bushels. Where an additional irrigation and one or two cultivations are given, twice this yield is frequently secured. These figures are on the basis of the standard weight, 56 pounds of seed to the bushel.

The yield of fodder secured varies with the method of planting, the thickness of the stand, the soil, and the season. Under favorable conditions, yields of 4 to 6 tons of cured fodder can be obtained from Kafir eorn, and $2\frac{1}{2}$ to 4 tons from the dura group. Sorghums of the dura group do not contain as much juice as Kafir corn, and hence the same bulk of dry fodder is much lighter. The usual yield of hay or fodder under ordinary conditions from all the nonsaccharine sorghums varies from 2 to 5 tons. The yield of green fodder or silage ranges from 6 to 12 tons ordinarily, but as much as 20 tons to the acre is sometimes obtained under very favorable conditions.

UTILIZATION OF THE CROP.

FODDER.

Kafir corn fodder (stalks before the heads are removed) has about the same feeding value as corn fodder, and can be used in the same way. Fodder from the other nonsaccharine varieties is rather less palatable than that from Kafir corn, and consequently ranks lower in feeding value. Brown dura and Jerusalem corn stalks are dry and pithy and do not make as good feed as yellow milo. Fodder from the better varieties of nonsaccharine sorghum makes excellent roughage for "wintering over" stock cattle or for feeding in addition to

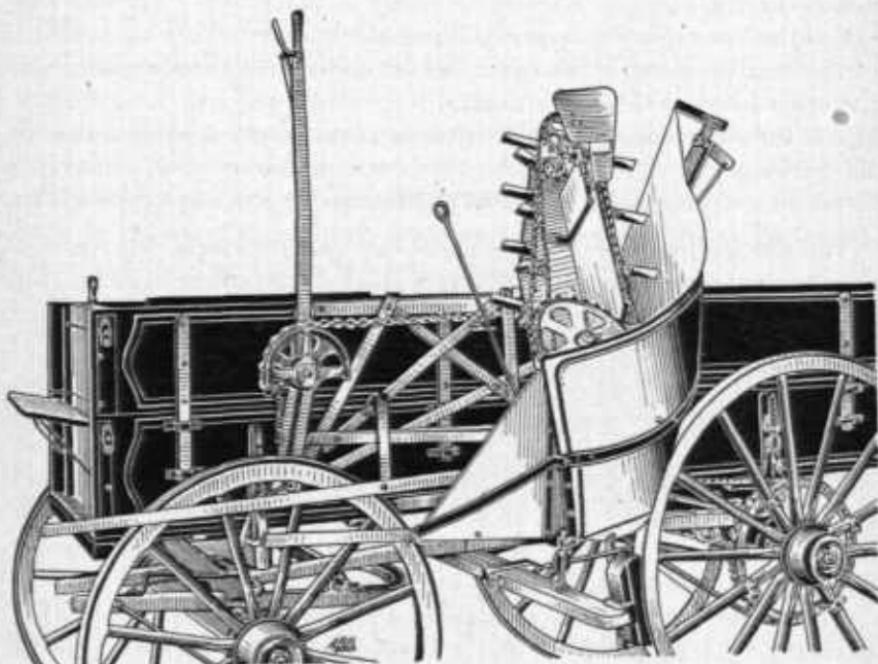


FIG. 9.—A Kafir corn header.

grain to fattening stock. With bran, alfalfa hay, or some other feed rich in protein, it is a good milk producer when fed to dairy cows. If the fodder is at all moldy or dusty, it should be fed after milking; otherwise the quality of the milk will be affected by the dirt and odor.

Although sorghum stover (stalks with the heads removed) is much lower in feeding value than the fodder, it is nearly as good as corn stover, and makes good roughage to feed with grain and alfalfa hay or as part of a maintenance ration for stock cattle. The stalks remaining in the field after the crop has been headed may be utilized by cutting and feeding as stover or by pasturing. The stalks of Egyptian corn are usually considered of little value.

While there may be some slight advantage in shredding fodder of the nonsaccharine sorghums, yet the gain is usually not enough to justify this expense. Practically the same result is accomplished by running the stalks through a thrasher, and this method puts the stover in excellent shape for feeding.

HAY.

The nonsaccharine varieties are not commonly used as hay crops, the saccharine sorts usually being sown when hay is desired. Kafir corn, however, makes excellent hay, which is fully equal to good sorghum or nearly equal to timothy for feeding. The other varieties of nonsaccharine sorghum are seldom grown as hay crops. The hay has about the same feeding value as the fodder, except that on account of the smaller stems stock eat it better and there is less waste. On the other hand, little seed is usually formed and the crop is cut before this is fully developed, so that there is a loss in the feeding value in this respect.

PASTURE.

The nonsaccharine sorghums make fair pasture crops, but are not usually considered equal to the best of the saccharine varieties for this purpose. Kafir corn makes better pasture than any of the other nonsaccharine sorts. Not less than a bushel of seed to the acre should be drilled in on well-prepared ground. Pasturing may begin when the plants are only a few inches high, but for the best results the crop should be allowed to grow at least 3 feet high before stock is turned into the field. They should be gradually accustomed to the feed by leaving them on it for only a short time during the first few days. When the crop is grown as pasture for hogs they should be turned in when it is about 18 inches high.

The sorghums should be available for pasture in about fifty or sixty days after sowing the seed, and will remain in good condition for at least thirty days. An acre of good Kafir corn will produce pasturage for 10 head of cattle eight to ten days. Under favorable conditions, if the cattle are taken off the field after the crop has been pastured down, it will make sufficient second growth in a month or six weeks to furnish considerable additional pasture.

In California, especially in the vicinity of Bakersfield, cattle are sometimes fattened by turning them into fields of mature dura or Jerusalem corn. These cattle have been pastured on alfalfa during the summer, and usually have the run of alfalfa pasture in addition to Egyptian corn when fattening. The results secured from feeding in this manner have been very satisfactory. The practice of pasturing the mature crop where alfalfa is not available can not be generally recommended.

Danger from poisoning.—The chief danger to cattle in pasturing on sorghum of any kind is from poisoning. Stunted plants, especially after a period of warm, dry weather, sometimes store up prussic acid in the leaves in sufficient quantity to cause death to cattle within a short time. Normal growth seldom contains injurious amounts of this substance. If by accident stock is poisoned from eating sorghum, the administration of large quantities of glucose (corn sirup or molasses) or of milk will frequently give relief. In curing, the prussic acid disappears, so that there is no danger from this source in feeding the hay or fodder.

SILAGE AND SOILING.

The nonsaccharine sorghums are little used for silage or for soiling, as these methods of feeding are not commonly practiced in the sections where they are grown. In sections adapted to their growth Kafir corn and milo will make rather better silage than the saccharine sorghums, as they contain less sweet juice and the percentage of grain to the whole plant is considerably greater. The abundance of sweet juice in the saccharine sorghums sometimes causes the silage to become quite sour and gives it a very disagreeable odor.

As a soiling crop the sorghums are desirable because they are available during July, August, and September, when most other crops are not in condition for feeding. They are specially valuable during a period of drought, when pastures are short, as they are little affected by dry weather and furnish a large quantity of succulent feed when it is most needed. The saccharine varieties are usually considered rather better than the nonsaccharine ones for soiling.

GRAIN.

Feed for cattle.—Numerous tests have shown that the most economical way of utilizing the grain of the nonsaccharine sorghums as a fattening ration is to thrash and grind or crush it, feeding with alfalfa hay or some other feed containing a considerable percentage of protein, such as cotton-seed meal or cake. The seeds of the sorghums are very rich in carbohydrates, or fat-forming materials, but are low in protein. The feeding of additional protein usually greatly reduces the cost of the gains secured. The amount required is comparatively slight, however. In a test conducted by J. J. Edgerton for the Texas Agricultural Experiment Station, using ground Kafir corn and milo and cotton-seed cake, with sorghum hay as roughage, better and more economical gains were secured from a ration containing 8.5 per cent of cotton-seed cake than from one containing about one-third more of the cake. As Kafir grain is constipating when fed in considerable quantities, it is advisable to feed with alfalfa

hay, cotton-seed cake, or milo grain, all of which tend to counteract this condition. With hogs following the cattle the loss from unground grain is partially recovered, but the feeding of the whole grain in large quantities is not advisable under any circumstances.

As a maintenance ration a small quantity of the grain may be fed with the stover, or the fodder may be fed. Probably this latter method is the more economical, especially if hogs follow the cattle. For feeding to dairy cows, the most economical ration where alfalfa is produced is alfalfa hay and Kafir corn or milo grain. Kafir corn is better than milo for feeding to calves with skim milk, as the constipating effect of the Kafir corn checks any opposite tendency due to the milk.

Feed for hogs.—The Kansas and Oklahoma agricultural experiment stations have shown that ground Kafir corn is nearly equal to corn meal as a fattening ration for hogs. The most economical gains at the Kansas station were secured by feeding a ration containing a small proportion of some feed rich in protein. No accurate tests have been made of the grain of the other nonsaccharine varieties for hog feeding, but there is no reason why they should not give fully as satisfactory returns as Kafir corn. Hogs soon tire of Kafir meal when it is fed alone, but when fed with alfalfa hay or some other feed high in protein, or when the hogs have the range of alfalfa pasture, they eat the Kafir corn as readily as corn. Dry, whole Kafir corn has proved a more satisfactory feed than the soaked grain, but wet Kafir meal has given slightly better returns than dry meal. Excellent results have been secured from feeding Kafir meal moistened with skim milk, as the skim milk provides the necessary protein in addition to making the meal more palatable.

Feed for sheep.—Very few tests have been conducted by the agricultural experiment stations in the feeding of these grains to sheep, nor have many farmers had experience along this line. Tests made by the Kansas Agricultural Experiment Station have shown practically the same gains from feeding Kafir meal as from shelled corn, alfalfa hay being used as roughage in both cases. The grain should be ground for feeding to sheep. Feeders in the Texas Panhandle, however, have secured quite satisfactory results from feeding the grain in the head, using millet and sorghum hay as roughage.

Feed for horses.—Kafir corn and milo are usually considered rather less heating than corn, and for that reason make better feed for horses during hot weather or when the animals are doing hard work. Kafir corn is an excellent grain to feed with alfalfa hay, as it counteracts the loosening effect of the hay on the bowels. Where both milo and Kafir corn are largely grown, farmers differ as to which is the better grain for horse feed. It is probable that a mixture of the two

is slightly better than either alone. The usual practice is to feed the grain in the head, though it is sometimes thrashed or crushed. Considerable waste will be prevented if the heads are run through a cutter before feeding. The fiber helps to lighten the ration and make the grain more digestible.

Feed for poultry.—The seed of all the nonsaccharine sorghums ranks high as poultry food. For fattening fowls the grain is about equal to corn and is much superior for feeding to laying hens. As the fowls get considerable exercise in picking the grain out of the heads, it should not be thrashed for feeding to breeding stock. In feeding the thrashed seed the best plan is to scatter it in straw or litter, thus causing the poultry to scratch for it. The thrashed grain should be used for feeding to fowls which are being fattened. Seed of the various sorghums forms a large part of many of the poultry feeds on the market.

THE GRAIN AS FOOD FOR MAN.

In the United States the grain of the nonsaccharine sorghums is not used to any great extent as food for man, although occasionally the meal is made into cakes or bread. White Kafir corn in particular makes a very good quality of meal and can be used like corn meal for all purposes. The milling of these grains has received little attention, but the possibilities of their use as food for man are considerable. In many parts of Asia and in central and southern Africa the seed of the various sorghums is largely produced for human consumption and forms as large a part of the food supply of the people as do rice and wheat in other sections.

FEEDING VALUE AND CHEMICAL ANALYSES.

Chemical analyses show that the nonsaccharine sorghums compare very favorably with corn, both as to grain and fodder. The fodder, in the green state and when cured, shows almost exactly the same amount of the various constituents as corn, and there is little difference in the digestibility of the two fodders. The heads of the nonsaccharine sorghums contain rather more water and crude fiber than ear corn, and weight for weight have considerably less value as feed. Analyses indicate that the grain is only slightly less valuable than shelled corn, but tests have shown that it is somewhat less digestible even when ground, on account of its hard, flinty character. In many feeding tests Kafir corn and milo have proved to be worth from four-fifths to seven-eighths as much as corn; that is, from four-fifths to seven-eighths of a bushel of corn equals in feeding value 1 bushel of the nonsaccharine sorghums. According to these figures the sorghums are worth 32 to 35 cents when corn is worth 40

cents, and 48 to 53 cents when corn is worth 60 cents a bushel. Figured on the basis of 100 pounds of each grain, the sorghums are worth 60 to 65 cents when corn is worth 75 cents, and 80 to 87 cents when corn is worth \$1.

MARKET FOR THE SEED.

Until two or three years ago there was very little demand for the grain produced by the nonsaccharine sorghums. Of late, however, a fair market has been built up, particularly for Kafir corn. Milo and the other sorghums are not yet much in demand except in a local way. In seasons when feed is scarce on the range the cattle men pay good prices for both the fodder and grain. The ruling prices for Kafir corn are much lower than for corn—frequently not more than half, a discrimination which is not justified by the difference in the feeding value of the two grains. In California the grain is usually worth nearly as much as corn. The Kafir corn which goes on the market is used in the making of poultry feed or is ground and sold as Kafir chop. It is also said to be used as an adulterant in corn chop, in shorts, and even in the lower grades of wheat flour. It is probable that some of it is used in the manufacture of certain brands of prepared breakfast foods.

DISEASES AND INJURIOUS INSECTS.

The principal disease which attacks the nonsaccharine sorghums is the grain smut of sorghum. This is quite prevalent and often destroys as much as 5 or 10 per cent of the crop. It may be kept in check by soaking the seed in hot water (132° to 134° F.) for fifteen minutes.^a This destroys the smut spores, but does not injure the seed. The grain should be dried immediately after the treatment. So far as the writer has observed, yellow milo is free from this disease. There is another smut which sometimes attacks the sorghums, known as the whole-head smut, which is similar to that affecting corn. This disease is most easily checked by seed selection. There are several other diseases which are occasionally present, but they seldom do serious damage.

A trouble sometimes experienced in wet seasons is the failure of the sorghums of all sorts to form seed. The injury is probably due to "scalding," which occurs during a period of hot, sunshiny weather immediately following a rain. The only preventive measure which can be taken is to make several plantings, so that they will come

^a The details of several methods of treating smut may be found in Farmers' Bulletin No. 250, "The Prevention of Stinking Smut of Wheat and Loose Smut of Oats." The same methods may be used in the treatment of sorghum smut.

into bloom at different dates and a part of the crop thus escape the unfavorable weather conditions.

Along the eastern border of the section where these crops are important, chinch bugs are often quite destructive. The sorghums are dense and succulent and furnish shade and food for the bugs when they are driven from the grain fields by the ripening and harvesting of the grain. Remedies for the chinch bug are discussed in Farmers' Bulletin No. 132.

IMPROVEMENT OF THE CROP.

The usual method of securing seed for planting is to take the thrashed grain from the bin or the heads as they come from the field. The yield of grain and fodder may be considerably increased by intelligent selection of the seed heads. In many sections it is desirable to increase the earliness of the crop. This may be accomplished by selecting the earliest maturing desirable heads in the field and planting these separate from the main crop. By selecting the early heads from this plot for two or three years a very material gain in earliness can be effected. In the same way desired results in increasing the size of the grain, the size of the head, the percentage of grain to the head or to the whole plant, or any other particular may be secured.

The desirable type for the production of both grain and fodder in Kafir corn is a stalk of medium height, juicy and sweet, without suckers or side branches, with a large number of broad leaves, and bearing a good-sized head well filled with grain. In the dura group a very desirable characteristic to be brought out is erectness of heads. In addition, the stalks should be of moderate height, uniform, quite juicy, leafy, and bearing a good-sized, rather open head well filled with large grain.

All the varieties of sorghum cross very readily, as the flowers are fertilized to some extent by pollen carried by the wind or by insects. For this reason the seed plot should be a considerable distance from any other variety of sorghum. The fact that the plants are frequently cross-pollinated gives an additional reason for selecting the best seed heads and growing a special seed plot. Under field conditions any variety of sorghum will soon become mixed by means of pollen blown from adjoining fields, and the crop will be irregular in height and maturity. The tall stalks shown in figure 7 are the result of this crossing, although the field illustrated was remarkably free from plants of this kind. The growing of seed as free as possible from this undesirable mixture is strongly to be recommended.

SUMMARY.

There are three distinct classes of sorghums: (1) The broom corns, (2) the saccharine sorghums, and (3) the nonsaccharine sorghums.

The important varieties of nonsaccharine sorghums may be divided into two groups: (1) Kafir corn and (2) the duras.

The varieties of Kafir corn are stocky, leafy, erect-headed sorghums; the dura group usually grows taller, is less leafy, and the heads are often goosenecked.

The nonsaccharine sorghums are important for the production of grain and forage in the semiarid sections of the West and Southwest.

These sorghums will grow on any good soil, but do best on a sandy loam.

All the varieties are remarkably resistant to drought and alkali, though they differ somewhat in their ability to withstand injury from these sources.

The bad effect on the land often attributed to sorghums is due largely to the poor physical condition in which they leave the soil and may be remedied by proper tillage.

The nonsaccharine sorghums should be planted two or three weeks later than corn, the quantity of seed and the method of planting varying with the section and the use that is to be made of the crop.

Frequent cultivation is desirable to keep down weeds and prevent evaporation of soil moisture.

The crop is usually harvested with a row binder, but may be cut by hand with a sled cutter, or in a number of other ways.

The crop may be headed and the heads thrashed, or the whole plant may be run through the thrasher.

Yields of 25 to 50 bushels of grain and 2 to 5 tons of dry fodder may ordinarily be expected.

The nonsaccharine sorghums may be fed as fodder or hay, as silage or as soiling crops; they may be pastured, and the grain may be fed to all kinds of stock. When fed in any of these ways, they compare very favorably with corn in food value. A bushel of the grain is worth about four-fifths as much as a bushel of corn from the standpoint of nutrition.

Chemical analyses indicate that the grain and fodder are about equal in feeding value to corn, but are slightly less digestible.

The prices usually offered for the grain are much less than it is really worth when compared with corn.

The earliness, quality, and yield of the crop may be greatly influenced by careful selection of the seed.